



Rivers and Streams

Missouri's rivers and streams are diverse and ever-changing ecosystems that move, store and transform water, sediment and organic matter. The healthiest streams are those with the least-altered natural processes.

Estimated Time

Three 50-minute
class sessions

Technology Tools/Skills Used in Chapter

- Invertebrate sampling technique for assessing water quality
- Invertebrate identification using a dichotomous key

Safety Precautions/Concerns

None

Vocabulary

Angler
Channel
Collector
First-order stream
Floodplain
Grazer
Invertebrate
Pool
Riffle
Riparian zone
Shredder
Stream bank

Chapter Objectives

Students will be able to:

1. Diagram the parts of a stream and explain how biotic and abiotic factors that make up the stream ecosystem function together.
2. Compare and contrast the adaptations of plants and animals living in flowing water to those of other aquatic and terrestrial species.
3. Predict the impact of flooding on the organisms in a stream ecosystem. Describe how technological solutions to problems, such as levees, dams and channelization, can have risks and unintended consequences. Describe possible solutions to potentially harmful environmental changes within a stream ecosystem.
4. Predict the changes in the number and types of organisms in a stream ecosystem based on stream order. Recognize the factors that affect the number and types of organisms a stream ecosystem can support.
5. Diagram and describe the transfer of energy in stream food web.
6. Assess the health of a stream based on the presence or absence of aquatic invertebrates.

Targeted Grade-Level Expectations

EC.1.A.6.a.
EC.1.B.6.a.
EC.1.B.6.b.
EC.1.B.6.c.
EC.2.A.6.a.
EC.2.A.6.b.
EC.1.D.6.a.
EC.1.D.6.b.
EC.1.D.6.c.
IS.1.C.6.a.

Reference Material for Teacher Background

- Critter Cards: Benthic Macroinvertebrates (STR295)
- DVD Compilation for *Conserving Missouri's Aquatic Ecosystems*
- Start a Missouri Stream Team (FIS182)
- Introduction to Crayfish (FIS011)
- Introduction to Missouri Fishes (FIS020)
- Life Within the Water (FIS034)
- Map: Smallmouth Bass (FIS019)
- Map: Trout Fishing In Missouri (FIS210)
- Missouri Aquatic Snails (SCI017)
- Missouri Fresh Water Mussels (E00019)
- Now That I'm a Stream Team... (FIS188)
- Poster: Missouri Fishes (E00013)
- Poster: Missouri Stream Life (E00016)

- Poster: Rivers and Streams: Missouri Currents (E00509)
- Stream Insects/Crustaceans ID (STR250)
- Stream Team Inventory Guide (FIS193)
- *Stream Team Middle School Activity Guide* by Mark Van Patten mostreamteam.org/activity_guide/contents.htm
- *Streets to Streams Guide* (E00428)
- Streets to Streams Video (E00447)
- Understanding Streams (FIS192)
- Volunteer Water Quality Monitoring (FIS049)
- Watershed Conservation: Impacts of Development (FIS263)
- Watershed Conservation: Nonpoint Source Pollution (FIS262)
- Watershed Conservation: Strategies for Coping with Stormwater (FIS261)
- What Happened to the Stream in My Backyard? (STR238)
- Why Watershed Conservation? (FIS260)
- *Crayfishes of Missouri* (01-0250)
- *Fishes of Missouri* (01-0031)
- *Missouri Naiads* (01-0150)
- *Pond Life: Revised and Updated (A Golden Guide from St. Martin's Press)* by George K. Reid

Required Materials

- DVD Compilation for *Conserving Missouri's Aquatic Ecosystems*
- Rivers and Streams: Missouri Currents poster (E00509)
- TV/DVD player
- Notebook paper
- Pens or pencils
- 30 wooden stakes approximately 4 foot in length, or music stands, or masking tape
- *A-Mazing Macroinvertebrates* signs on paper or cardstock and laminated or placed in plastic sheet protectors
- Chalk, plastic non-adhesive survey tape or spray paint outside, or vinyl electrical tape, string or plastic non-adhesive survey tape indoors

Activity 7.1: Exploration of Students' Current Understanding of Missouri's River and Stream Ecosystems

This activity explores students' current understanding of Missouri's river and stream ecosystems.

Estimated Time

15 minutes

Required Materials

- Rivers and Streams: Missouri Currents poster (E00509)
- Notebook paper
- Pens or pencils

Procedure

1. Display the Rivers and Streams: Missouri Currents poster in the classroom.
2. Ask students to use their notebooks to free-write, brainstorm, mind-map or cluster for five minutes everything they know about rivers and streams. Lead class discussion by asking each student to contribute something to the board without repeating an item. Have students add to their notebooks any information on the board that they hadn't already included. Leave these items on the board for use in Activity 7.2.
3. Explain to the class that this chapter will help them understand what a stream ecosystem is and how it functions.

Activity 7.2: Video Exploration of Missouri's River and Stream Ecosystems

This activity helps students understand Missouri's river and stream ecosystems.

Estimated Time

35 minutes

Required Materials

- DVD Compilation for *Conserving Missouri's Aquatic Ecosystems*
- TV/DVD player
- Notebook paper
- Pens or pencils

Procedure

1. Show the video: "Streams: The Force of Life." Pause the video frequently and discuss facts, concepts and misunderstandings students wrote on the board in Activity 7.1 as they arise in the video.
2. Have students make notes in their science notebooks.
3. As time permits, show the video clips: "River of Many Uses" and "Mississippi River Monitoring."

Activity 7.3: Student Reading and Research

This activity provides students with definitions and explanations about Missouri's river and stream ecosystems.

Estimated Time

Varies—class time may be provided or reading may be assigned as homework. Allow at least 20 minutes for in-class questions and discussion.

Required Materials

- Student Guide
- Notebook paper (optional)
- Pens or pencils (optional)

Procedure

1. Have students read Chapter 7: Rivers and Streams. Introduce vocabulary terms as needed.
2. Assign the **Questions to Consider** as homework or use them in a cooperative learning activity.
 1. What are the parts of a stream? How do they function together?
Channel—the part of the stream where water collects to flow downstream
Pools—the deeper, slower-moving places in the stream channel
Riffles—the shallow, faster-flowing places in the stream channel
Stream banks—the shoulder-like sides of the stream channel
Riparian zone—the land next to the stream (starting at the top of the stream bank)
Floodplain—the flat land on both sides of the river or stream where extra water spreads out during a flood
See also FIG. 7.1 and section titled “Anatomy of a stream” in student guide Chapter 7.
 2. What is the riparian zone? Why is it important to have plenty of plants growing alongside a stream?
The riparian zone is the land next to the stream (starting at the top of the stream bank). A riparian zone with heavy plant cover 100 feet on either side of the stream may be the stream's best defense against pollution and other problems in the watershed. Plants growing in the riparian zone keep the stream healthy in many ways. Trees shade and cool the water, which increases the amount of dissolved oxygen the water can hold. Roots help hold the stream banks together. Leaves and branches falling into the water provide organic matter for aquatic food webs. Riparian plants offer habitat to birds, bats and other wildlife.
 3. What is the floodplain? Are floods natural disasters?
The floodplain is the flat land on both sides of the river or stream. During a flood, a stream's extra water spreads out to cover the floodplain. Flooding is a natural characteristic of all streams. By allowing excess water to spread out, floodplains reduce the floodwater's speed. As a result, less damage occurs in the stream and to regions downstream. While we tend to think of floods as natural disasters, they are really natural events and processes that have positive effects on stream ecosystems. The only disaster comes when humans put things in the water's way.
 4. What is stream order? How can it help us understand the aquatic community living in a particular place?
A first-order stream is a small stream with no tributaries coming into it. First-order streams combine to form larger second-order streams. These larger streams combine to form even bigger third-order streams and so on. A stream's order or size determines the aquatic community it can support. Headwaters, first- and second-order streams have no rooted or floating plants, so aquatic animals depend on debris that falls or is washed into the water. These conditions favor shredders and small fish. Third- through fifth-order streams have both rooted and floating aquatic plants and many more types of animals. In a big river, few rooted plants grow because the water is too deep and very cloudy. Big river conditions favor plankton, collectors and large fish.

5. What can the presence or absence of aquatic invertebrates tell us about the health of a stream?

Water quality experts look for certain invertebrates that live in riffles on the stream bottom. Examples include the immature stages of stoneflies, caddisflies and mayflies. These insects are sensitive to pollution. The presence of such species generally indicates good quality water. When they are missing from a stream or when only pollution tolerant species such as black fly larvae and bloodworms are present, we know that something is wrong with the water. Biodiversity—a high number of species—as well as a high number of sensitive species living in a stream are good signs of a healthy stream.

6. How are plants and animals adapted to living in flowing water?

Plants living in moving water have long, thin, flexible stems that offer little resistance to the current and strong root systems to hold them in place. Mussels burrow to avoid the current and snails use a broad, flat foot to stick to rocks. Water birds have long legs for wading and hunting or webbed feet for swimming and diving. River otters have an oily coat to keep them dry and warm. Fish such as bleeding shiners have streamlined bodies that allow them to remain stable in currents. Sculpins and many darter species are adapted as bottom clingers. They tend to have flattened heads and large pectoral fins that are angled to help them stay on the bottom in swift currents. With these advantages they can stay in the swift water of riffles and pick invertebrates from the rocks.

7. How can rivers and streams be kept healthy?

The healthiest streams are those with the least-altered natural processes. A riparian zone with heavy plant cover 100 feet on either side of the stream may be the stream's best defense against pollution and other problems in the watershed. Avoid building roads, houses and levees in floodplains. Remember that everything that happens on the land in a watershed affects the waterbody into which it drains. Use land and water resources wisely and protect your watershed. Join a Missouri Stream Team and help clean up a stream in your community, learn to check water quality, learn more about watershed conservation, and take part.

Activity 7.4: Student Investigation of Stream Anatomy and River and Stream Food Webs

This activity helps students understand river and stream food webs.

Estimated Time

25 minutes

Required Materials

- Rivers and Streams: Missouri Currents poster (E00509)
- Notebook paper
- Pens or pencils
- Red, green and black yarn
- Scissors
- Pushpins or thumbtacks
- Set of Stream Anatomy Cards

Procedure

1. Display the Rivers and Streams: Missouri Currents poster in the classroom.
2. Have students take turns cutting lengths of yarn and using pushpins attach them to the poster to diagram the food web connections between the plants and animals depicted in the poster. Tell students to use red yarn to connect a predator to its prey. Have students use green yarn to connect primary consumers to producers. Use black yarn to connect scavengers and decomposers to their food. Also have students attach the Stream Anatomy Cards in the proper places.
3. Lead class discussion of river and stream food webs, with reference to the poster and to FIG. 7.4 in the Student Guide.
4. Ask students to predict the impact of flooding on the organisms in a stream ecosystem. (A flood could wash some fish, plants or other aquatic life away, but would not cause long-term damage. It could even have benefits, such as restoring wetland areas and bringing fresh nutrients.) Ask students to predict the impact of cutting down all the trees and removing the plants from the stream banks and riparian zone on the organisms in a stream ecosystem. (Without plants to hold the rocks and soil in place, the stream banks would erode, filling the stream's pools with sediment. Major erosion and sedimentation can smother aquatic life and destroy their habitat. Without plants growing in the riparian zone, the water would heat up in the sun, which would decrease the amount of dissolved oxygen the water can hold. No leaves and branches falling into the water would deprive the stream food web of organic matter. Lack of riparian plants would mean loss of habitat to birds, bats and other wildlife.
5. Have students write science notebook entries diagramming the parts of a stream and explaining how the biotic and abiotic factors that make up the stream ecosystem function together, including how a stream's order or size determines the aquatic community it can support.

Stream channel

The channel of the stream is where water concentrates to flow downstream. It includes the bed, the gravel bars and the stream banks. Stream channels always follow a downhill path.

Riffles

Shallow and fast-flowing water in the stream channel. Riffles mix oxygen into the water.

Flood plain

A relatively level area on both sides of the stream channel that carries excess water the channel cannot handle during a flood. Allowing excess water to spread out reduces the floodwater's speed, reducing damage downstream.

Riparian zone

The land bordering a stream channel that begins at the top of the stream banks. A riparian zone at least 100 feet wide and full of plants helps protect the stream ecosystem.

Pools

Deeper, slower-moving places in the stream channel.

Stream bank

The stream banks are the shoulder-like sides of the stream channel from the water's edge up to the adjacent higher ground. Stable stream banks have plants growing on them that help hold the soil in place and minimize erosion.

Activity 7.5: Video Instruction for Invertebrate Sampling

This activity helps students understand the techniques used for invertebrate sampling. It helps students understand the use of biodiversity and indicator species to assess water quality.

Estimated Time

25 minutes

Required Materials

- Volunteer Water Quality Monitoring Instructional Video
- TV/DVD player
- Notebook paper
- Pens or pencils

Procedure

1. Review with the class paragraph 12 of Chapter 7 in the Student Guide. Explain that the video will show them how to sample a stream for invertebrates. Finding a diverse group of invertebrates, including those that are sensitive to pollution, indicates that the stream has high water quality.
2. Show the video clip: “Stream Invertebrates Sampling.” Ask students to follow along on the instruction sheet as the different sampling methods are depicted. Pause the video as needed to clarify, discuss and review.
3. If desired, distribute copies of the Invertebrate Sampling Instructions and data pages (see Field Study Day section) for students to follow along with the video.

Activity 7.6: Student Investigation of Invertebrate Identification

Adapted from "A-Mazing Macroinvertebrates" by Rhonda Anderson, Missouri Department of Conservation

This activity helps students learn to identify invertebrates in preparation for their field study day. It helps students understand how to use dichotomous keys.

Estimated Time

25 minutes

Required Materials

- 30 wooden stakes approximately 4 foot in length, or music stands, or masking tape
- *A-Mazing Macroinvertebrates* signs (printed from a PDF on DVD Compilation for *Conserving Missouri's Aquatic Ecosystems*) on paper or cardstock and laminated or placed in plastic sheet protectors
- Chalk, plastic non-adhesive survey tape or spray paint outside, or vinyl electrical tape, string or plastic non-adhesive survey tape indoors

Procedure

1. This activity is a maze that uses a large open space such as a grassy field or a gymnasium. This activity lends itself better to outdoor situations, but it can be done inside when ample space is available.
2. Using a permanent marker, write the letter corresponding to the layout on the back of each sign. Write a corresponding letter on each invertebrate picture to allow the student to know if he or she has correctly identified the invertebrate.
3. For an outdoor set up, use 30 wooden stakes approximately 4 foot in length. Attach the signs with staples or velcro and drive stakes into the ground. For an indoor set-up, use music stands or tape the signs directly on the floor.
4. Make lines connecting the stations at right angles. Use chalk, plastic non-adhesive survey tape or spray paint outside or vinyl electrical tape, string or non-adhesive survey tape inside. Always ask permission to use spray paint before applying to grass of a public lawn. If using string or tape, be sure to place it close to the ground at each station to avoid tripping.
5. This key was designed for use with specific invertebrates. Pictures of the 15 invertebrates are included to ensure that the students are able to properly key them out. Each invertebrate should be labeled with letters corresponding to the sign. This way the students will be able to know immediately if they are correct. (Caution, some students will just look for the matching letter!) You will also be able to match the invertebrate to the answer key and know if the students are correct.
6. Walk through the maze with a couple of different invertebrates to ensure that the maze is set up correctly.
7. Emphasize to students the importance of proper handling of the pictures to minimize wear. Review with the class the important points of invertebrate anatomy before starting. These include: head, thorax, abdomen, gills, wing pads, prolegs, segmented legs and lateral filaments.
8. Allow students to select an invertebrate and review its anatomy. Explain any vocabulary words that may be unfamiliar to the students. The key to success is in looking at the correct body part for each clue.
9. Go over the first clue with the students and explain how to follow the maze. Tell them to read both options before making any decisions.

10. Each student should walk through the maze with the picture of the invertebrate in hand, making choices and eventually reaching a dead end—the name of their invertebrate.
11. Sometimes students will need correction on a selection. Encourage them to return to the start of the maze until their invertebrate is correctly identified.
12. Encourage students to select another invertebrate and repeat the process as time permits.
13. Students can be paired up to go through the maze. Students having problems can be reassigned a partner who has been successful at identifying several invertebrates.

Chapter 7 Assessment

Directions

Select the best answer for each of the following multiple-choice questions.

1. Predict the impact of flooding on the organisms in a stream ecosystem.
 - a. Some fish, plants or other aquatic life could be washed downstream.
 - b. There would be no long-term damage.
 - c. Fresh nutrients would be brought in.
 - d. All of the above
2. Predict the types of organisms in a fourth-order stream.
 - a. Few rooted plants grow because the water is too deep and very cloudy; there are more collectors than shredders, for example: black willow, smartweed, buttonbush, silver maple, cottonwood, sycamore, mayfly, gilled snail, stonefly, crayfish, green sunfish, creek chub and fathead minnow.
 - b. Both rooted and floating aquatic plants and many types of animals have a niche in which to live, for example: algae, water willow, coontail, silver maple, sycamore, mayfly, gilled snail, crayfish, damselfly, scud, channel catfish, bluegill, largemouth bass and longnose gar.
 - c. There is little aquatic plant growth; animals depend on what falls or is washed into the stream.
 - d. None of the above.
3. Sculpins and many darter species are adapted as bottom clingers. They:
 - a. Have streamlined bodies that allow them to remain stable in currents
 - b. Have flattened heads and large pectoral fins that are angled to help them stay on the bottom in swift currents
 - c. Have upturned eyes and mouths to slurp down mosquito larvae
 - d. None of the above
4. Which of the following statements is true:
 - a. In a straight stretch of river, the main force of the current is in the middle. The deepest water is also in the middle.
 - b. When there is a sharp bend in the river, the strongest current and deepest water is at the outside edge of the bend.
 - c. In flowing water, there is less current near the bottom.
 - d. All of the above
5. Plants living in moving water have:
 - a. Long, thin, flexible stems that offer little resistance to the current and strong root systems to hold them in place
 - b. Are tiny, free-floating species of algae and are the food base of the ecosystem
 - c. Are tall because they have greater support, enabling them to rise above other plants to reach the sun
 - d. None of the above

Chapter 7 Assessment

Directions

Write your own answer for each of the following questions.

1. Describe how technological solutions to problems can have risks and unintended consequences. Justify your answer by using one of the following as an example:
 - Building a levee in the floodplain
 - Damming a stream
 - Channelizing (straightening) a river
2. Suggest a possible solution to potentially harmful environmental changes within a stream ecosystem caused by the technical solution you chose in the previous question.
3. Diagram the parts of a stream and explain how biotic and abiotic factors that make up the stream ecosystem function together. Use the back of this page.

Chapter 7 Assessment Answer Key

Multiple-choice questions

- Predict the impact of flooding on the organisms in a stream ecosystem.
d. All of the above
- Predict the types of organisms in a fourth-order stream.
b. Both rooted and floating aquatic plants and many types of animals have a niche in which to live, for example: algae, water willow, coontail, silver maple, sycamore, mayfly, gilled snail, crayfish, damselfly, scud, channel catfish, bluegill, largemouth bass and longnose gar.
- Sculpins and many darter species are adapted as bottom clingers. They:
b. Have flattened heads and large pectoral fins that are angled to help them stay on the bottom in swift currents
- Which of the following statements is true:
d. All of the above
- Plants living in moving water have:
a. Long, thin, flexible stems that offer little resistance to the current and strong root systems to hold them in place

Write-in questions

- Describe how technological solutions to problems can have risks and unintended consequences. Justify your answer by using one of the following as an example:
 - Building a levee in the floodplain
 - Damming a stream
 - Channelizing (straightening) a river

Many answers are possible, but should resemble one of the following examples:

Technological solution	Potential risk or unintended consequence
Building a levee in the floodplain	Building levees prevents the natural functioning of the floodplain to allowing excess water to spread out, slow down and release sediment and nutrient. This causes floodwaters to rise even higher, move faster and do more damage. It also prevents the natural replenishment of floodplain soil and wetland ecosystems. Some fish depend on flooding to trigger spawning, which takes place in the shallow water of the flooded floodplain. Levees prevent these fish from spawning, which could result in their extinction.
Damming a stream	Damming a river turns the stream ecosystem into a lake ecosystem. Species adapted to live in flowing water may not be able to survive in the still water of the lake. Also, as dams slow and stop the flow of water, the sediment the water carried drops out and builds up as the stream becomes a lake, further destroying stream habitat. Below the dam, the rushing water scours out the stream bed, destroying more habitat and causing severe erosion downstream. Dams also prevent fish from moving up or down stream, potentially isolating them from other populations or from spawning grounds upstream.
Channelizing (straightening) a river	Channelizing or straightening a stream increases the water's downhill speed. This worsens erosion and sedimentation as the stream tries to return to a natural path. In the process, habitat is destroyed and water quality is reduced.

2. Suggest a possible solution to potentially harmful environmental changes within a stream ecosystem caused by the technical solution you chose in the previous question.

Many answers are possible, but should resemble one of the following examples:

Technological solution	Potential risk or unintended consequence	Possible solution
Building a levee in the floodplain	Building levees prevents ... in their extinction.	Remove or do not build levees. Instead, allow floodplains to perform their natural function. Do not build in the floodplain. Instead, use the land for low-impact agriculture and recreation.
Damming a stream	Damming a river ... spawning grounds up-stream.	Remove or do not build dams. If this is not possible, create new habitat elsewhere to make up for habitat lost to the dam. Spawn fish artificially. Create fish passages around the dam (fish ladders). Build something (partial barriers, check dams, grade control structures) to slow the water down when it comes out of the dam, to reduce damage downstream.
Channelizing (straightening) a river	Channelizing or straightening ... quality is reduced.	Do not straighten streams. When channelization has already been done, try to dig a zig-zagging channel for the stream to return to, or just let the stream find a new path on its own. Protect the soil from erosion as much as possible by keeping plenty of plants, especially trees or prairie plants, growing in the area.

3. Diagram the parts of a stream and explain how biotic and abiotic factors that make up the stream ecosystem function together. Use the back of this page.

Refer to FIG. 7.1 and FIG. 7.5 in the Student Guide to assess potential responses.

Enrichments

Project WET:

- After Math
- Macroinvertebrate Mayhem

Project WILD Aquatic:

- Blue Ribbon Niche
- Riparian Retreat
- To Dam or Not to Dam
- Water Canaries

Demonstration:

- Stream Table

Service learning:

- Storm drain stenciling
- Litter pickup

Guest speaker:

- Soil and water conservationist
- Stream Team volunteer water quality monitor. If invited for activities, the speaker may be able to assist with instruction as well as talk about volunteer opportunities and stream issues.

Video clips:

- Our Corner of the World
- Ozark Mountain Paddlers